Tomentosus Root Disease

Yukon Forest Health — Forest insect and disease

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Yukon
Energy, Mines and Resources
Forest Management Branch

Introduction

Tomentosus root disease (*Inonotus tomentosus*) is a slow growing root rot of coniferous trees, particularly spruce (*Picea spp.*). Tomentosus is assumed to occur throughout the host range in Yukon, however only limited surveying has occurred. Tomentosus does cause tree mortality but generally takes decades to kill mature trees. Surveys in the Shakwak Trench and LaBiche River found that more than 40% of trees were infected by the disease, but signs were limited almost entirely to the incipient stain, with only 1% of the trees showing advanced root decay. Disease incidence was higher on wetter sites (i.e, Dezadehash Lake and Labiche River). In managed forests, tomentosus can cause more severe mortality where infected stumps provide inoculum for young regenerating trees.

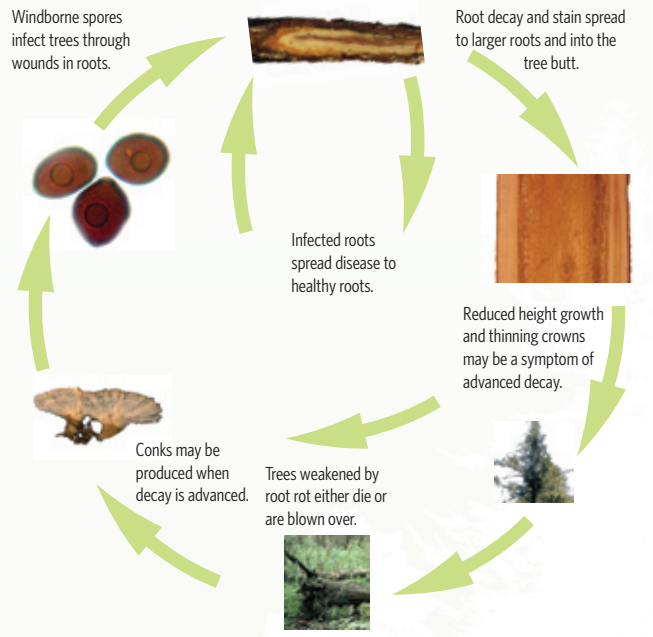
Host Range for Tomentosus Root Disease

(Source data: Yukon Government Forest Inventory Data [2008] and U.S. Geological Survey [1999] Digital representation of "Atlas of United States Trees" by Elbert L. Little, Jr. (http://esp.cr.usgs.gov/data/little/) *Disclaimer: The data set for historic incidence is likely incomplete and only extends from 1994–2008. Endemic or outbreak populations may have occurred or may currently exist in non-mapped locations within the host range.*

Forest Health Program
Forest Management Branch
Energy, Mines and Resources
Government of Yukon
P.O. Box 2703 (K-918)
Whitehorse, YT Y1A 2C6

867-456-3999
Toll free in Yukon: 1-800-661-0408, ext. 3999
www.forestry.emr.gov.yk.ca

Disease Cycle



The disease cycle of *Inonotus tomentosus* is not completely known. However, it is thought that two primary mechanisms of infection exist:

1) Mycelial spread facilitated by root to root contact or root grafting from infected to healthy host trees — it is thought that mycelia can directly penetrate the bark of small roots to infect healthy trees (<5 cm diameter); and
2) Windborne spores infecting roots, presumably through wounds.

Surveys in Yukon have suggested that once infection has occurred, the fungus may survive in the roots of mature trees without causing significant decay for many years until the host tree comes under some form of stress (e.g., decadence, overcrowding or drought). When the disease finally progresses it is slow growing, spreading at a rate of approximately 3 to 4 cm per year. As the fungus spreads it causes decay through the roots towards the base of the tree, eventually infecting the heartwood in the tree butt and up to 2.5 metres up the main stem. It can take decades for the fungus to severely infect a large tree. Once the fungus is sufficiently established in the host, and if the appropriate

environmental conditions exist, the fungus may initiate sexual reproduction and form above ground fruiting bodies (conks) in the fall. Normally the conks are on the ground adjacent to the tree. The conks release spores that can spread and cause new infections. However, most infection is spread clonally through mycelial growth from diseased to healthy roots. Mycelia can only grow 2–3 cm outside of the host material, therefore diseased roots must almost be touching healthy roots in order to spread infection.

The fungus grows primarily in living hosts but can survive in dead material for up to 30 years, which means that the inoculum remains in the soil long after the host tree has died. Subsequent disturbance such as fire, harvesting, thinning or windthrow does little to remove inoculum. Therefore, young trees of the host species that are planted or regenerating on the site may be infected by existing inoculum in remaining stumps and roots.

Host Species Attacked and Damage

Tree species attacked in Yukon: Spruce is highly susceptible but subalpine fir (*Abies lasiocarpa*), larch (*Larix laricina*) and lodgepole pine (*Pinus contorta*) are also susceptible. Broadleaf species are immune. Trees of all ages are susceptible.

When trees are not under stress, there may be no difference in appearance between infected and uninfected trees. Infected, mature trees are likely to persist with no sign of infection for many years. Susceptibility to infection is not thought to vary with age. Older, larger trees are more likely to become infected due to their extensive root systems and increased probability of exposure over time. Younger trees, once infected, are prone to more rapid mortality due to their smaller root systems. Less vigorous, stressed, over mature and decadent trees that are infected with tomentosus are less able to defend against the advance of the disease, both in terms of the progression from stain to rot and spatial progression up the roots and into the butt of the tree.

Roots of infected trees exhibit a pink stain in the early stages of infection, usually in the heartwood, which darkens as the disease advances. The cambium of smaller roots (<4 cm diameter) may be killed. Early signs of decay appear as small, slightly yellow pits. As decay advances, pits expand into a

honeycomb pattern of white pits. In its final stages, the pits no longer contain mycelium and the honeycombed structure is all that remains.

As the infection spreads, the roots and butt of the tree decay making it more prone to stem breakage and windthrow. Though it has been suggested by some authors, no significant evidence has been found linking tomentosus infection to an increased incidence of spruce beetle attack. This was supported by the study done within the spruce beetle infestation in southwest Yukon that found no difference in incidence of infection between infested and uninfested trees. Because infection usually spreads from tree to tree, clumps of fallen trees form small openings in the stand that are often a sign of root disease. If roots are exposed on the fallen tree, they will typically appear as short sections of major roots with obvious signs of honeycombed pitted decay. Stumps may also show this pattern. In managed stands, infected stumps and roots provide a source of inoculum in the stand that can infect regenerating seedlings and result in insufficient stocking.

Severely infected trees will develop crown symptoms such as thin foliage, chlorosis, reduced leader growth, and distress cone crops. Branch mortality tends to begin at the bottom of the crown and progress upward. Tree crowns may appear healthy even when up to 80% of the root system is infected because the sapwood of larger roots can remain uninfected. For trees to exhibit crown symptoms, generally 60% of the root system has been killed and more than 80% is infected. Tree volume is not significantly affected until more than 75% of the root system has been infected. Substantial volume losses in butt logs can be associated with decay in severely infected stands.

Definitive identification of tomentosus root disease is only possible if hyphae from decayed roots are cultured in the laboratory or with careful identification of the fruiting body.

Definition:

Cambium: *the actively dividing layer of cells which produces the conducting tissues in a tree, therefore increasing the girth of the tree.*

Chlorosis: *a condition in which leaves produce insufficient chlorophyll.*

Hyphae: *fine, white, branched filament that is the vegetative body of a fungus.*

Resinosus: *a flow of resin or pitch in a conifer, in response to an infection, wounding or insect (often beetle) attack.*

Unless stands are severely infected, below ground symptoms are more reliable indicators than above ground symptoms. The following signs are good indicators of tomentosus:

- Root exhibits pink to red-brown coloured staining. This pattern progresses from the interior of the root outwards **(photo 1)**.
- Decayed wood contains large (1 cm long), canoe shaped pits that are either empty (honeycomb appearance) or full of white hyphae (white pits) and are separated by red-brown firmwood. In the early stages of decay, pits may appear yellowish **(photo 2)**.
- Stand openings have randomly oriented windthrown trees lacking the fine root mass **(photo 3)**.
- The tree crowns exhibit chlorotic, thinning foliage, distress cone crops, reduced leader growth and/or lower branch mortality **(photo 4)**.
- Leathery conks with tan, velvety upper surfaces and cream coloured under surfaces may form. The whole conk becomes dark with age. Pores are found on the underside of the conks and partway down the stem. Conks range in size from 2–11 cm in diameter and are up to 1.5 cm thick. These fruiting bodies appear from August to October and are usually only present after rains and warmer temperatures. In Yukon, fruiting bodies matching this description are almost always tomentosus **(photo 5 and photo 6)**.
- Rarely, cankers and resinosus may be present at the base of stems and near the root collar.

Photo number:

1. **Discoloured root tissue.** Citation: Richard Reich, Natural Resources Canada, Canadian Forest Service.
2. **Decayed wood.** Citation: Natural Resources Canada, Canadian Forest Service.
3. **Fallen tree with decayed roots.** Citation: Linda Haugen, USDA Forest Service, Bugwood.org
4. **Crown symptoms.** Citation: Eric Allen, Natural Resources Canada, Canadian Forest Service.
5. **Fruiting bodies.** Citation: André Carpentier, Natural Resources Canada, Canadian Forest Service.
6. **Fruiting bodies at stem base.** Citation, William Livingston, University of Maine, Bugwood.org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Similar damage

Tomentosus root disease can be confused with other root diseases, bark beetles and abiotic disturbances.

Inonotus circinatus may be present in Yukon (it is confirmed in British Columbia but not found in Alaska) and it is difficult to differentiate between this species and *Inonotus tomentosus* unless the fruiting bodies are present. The conks of tomentosus are smaller and thinner and usually form in groups whereas those of *I. circinatus* are large, thick and shelf-like. They tend to be individually found on dead roots or at the base of the stem.

The advanced stages of decay may also be confused with the heartrot, *Phellinus pini*. Phellinus enters the host through natural openings such as twig or branch stubs and colonizes the central part of the tree. The white pitted pattern of decay is very similar to tomentosus in that both cause honeycombed pitting in the wood. However, Phellinus tends to cause individual tree mortality rather than group tree mortality because it is not spread from root to root. Also *P. pini* conks are limited to the tree bole and are usually associated with branch stubs or knots. The knots will swell with a brown, punky interior and are commonly known as punk knots, whereas tomentosus conks appear on the base of the tree or on the ground.

Risk Assessment

The following tables summarize the likelihood of occurrence and magnitude of impact of an outbreak at the stand level. These tables are a coarse guide for estimating the risk of an outbreak when populations are at endemic levels.

Likelihood of Occurrence

Stand Hazard:	High → Low	
Site moisture[1]	Dry-Moist	Very wet/Very dry
Second growth stand[2]	Infected stumps	No evidence of historic infection
Tree age[3]	Old	Young
Stand health[4]	Stressed/Decadent	Vigorous

Notes:

1. Tomentosus prefers well-drained sites but grows poorly on very dry and very wet sites.
2. Stumps of previously infected hosts provide a source of inoculum for live trees in the second growth stand.
3. Older trees are more likely to be infected due to exposure over time.
4. Stressed/decadent stands are more susceptible to spread of infection.

Magnitude of Consequence

The magnitude of consequence is a subjective assessment of the potential consequences of an outbreak. This list is not exhaustive and is intended to stimulate thought on potential impacts to consider over time.

Value	Impact							
	-							+
Traditional Use[1]								
Comment:	No impact anticipated							
Visual Quality[2]								
Comment:	No impact anticipated							
Timber Productivity[3]								
Comment:	Mortality & reduced growth (-)							
Wildfire Hazard[4]								
Comment:	No impact anticipated							
Public Safety[5]								
Comment:	Hazard trees (-)							
Hydrology[6]								
Comment:	No impact anticipated							
Time Scale (years)	20+	15	10	0-5	0-5	10	15	20+
Comment:	Impact refers to a predicted, substantial positive (+) or negative (-) impact on a value for an estimated time period							

Notes:

1. In this context, traditional use values considered are hunting, trapping and understory shrub/plant use. Given that tomentosus causes gradual and limited mortality, no impact is anticipated.

2. Given that tomentosus causes gradual and limited mortality, no impact is anticipated.

3. Impacts on timber productivity are a concern if young, second growth stands are infected by pre-existing inoculum in residual stumps as they are more likely to experience reduced growth and/or mortality. Also, mature stands exhibit the same reduction in productivity; therefore, timber productivity is negatively impacted.

4. Given that tomentosus causes gradual and limited mortality, no impact is anticipated.

5. Tomentosus infection is likely to create hazard trees by weakening tree stem and root bases and making stems more prone to breakage.

6. Given that tomentosus causes gradual and limited mortality, no impact is anticipated.

Implications of Climate Change

General Circulation Model (GCM) results in the 2007 Intergovernmental Panel on Climate Change (IPCC) report indicate that warming in northern Canada is likely to be greatest in winter (up to 10°C) and warmer by 3–5°C in summer. Mean annual precipitation is also predicted to increase (particularly in fall and winter). More rainfall is expected on windward slopes of the mountains in the west, therefore the rain shadow effect of the St. Elias Mountains may mean that southern Yukon does not experience increased rainfall. High temperatures will increase levels of evaporation and transpiration, and ultimately lower soil moisture levels. Therefore, even if summer rainfall is maintained at current average levels, higher temperatures would result in limited soil water availability and cause moisture stress in trees. Currently, climate scenarios suggest that Yukon will experience a warmer climate that will be wetter or drier in the future depending on the region.

The spores of *Inonotus tomentosus* are windborne; therefore, dispersal is unlikely to be impacted as a direct result of a warmer/wetter or warmer/drier climate. Tomentosus may benefit from warmer, drier temperatures because increased drought stress in host trees may increase colonization success. If summer conditions are wetter in the future, the opposite would be true as host trees would not be moisture stressed.

Management Options

Monitoring

Tomentosus damage, where the disease is advanced, can sometimes be viewed from aerial surveys but is best determined from ground surveys. The best time of year for ground surveys is from August to October, particularly after rains and warmer temperatures when fruiting bodies may be present. Root sampling is laborious and time consuming; therefore, reduce the number of trees being sampled by sampling only those trees that are in the vicinity of some clumps of standing dead trees or windthrown trees with root balls. Also, pre-stratify stands based on ecological indicators. For example, areas that consistently have a high water table (e.g. bogs) will probably have very little or no root disease and can be eliminated from surveys. For information about aerial surveys refer to BC aerial survey standards (MoF, 2000). For strategic planning information, refer to the Forest Management Branch risk-based monitoring strategy (Ott, 2009).

Direct Control

Direct control methods are not suitable for tomentosus root disease. No known biological or chemical control agents exist.

Harvesting Considerations

Harvesting may occur either as a by-product of private/industrial land clearing or if a commercial forestry operation is undertaken. If there is a high incidence of advanced root disease, avoid partial cutting or thinning as this may result in increased inoculum in cut stumps. It may be possible to reduce inoculum by removing the stump and most of the root system via a push-over falling method implemented during harvesting or destumping post-harvesting. However, this treatment causes extensive soil disturbance, is expensive and may not be economically viable. Severely decayed roots may be impossible to remove so some inoculum is likely to remain.

Silvicultural Considerations

Silvicultural considerations are relevant if a stand is being managed for commercial forestry or if an area is being replanted. Stump-top surveys to determine the incidence of advance decay in the harvested trees can help determine if white spruce can safely be replanted on the site. If there is a high incidence of advanced root disease, encourage the growth of less susceptible species either by planting or natural regeneration. If no suitable alternative conifer species can be found, another option is to favour the growth of broadleaf tree species such as paper birch or trembling aspen. If planting susceptible species, trees should be planted at least 3 m from old, infected stumps.

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